

thorough investigation as practicable of conditions in each locality in the preliminary plans for school buildings, and this generally can be done through near-by Weather Bureau stations.

It is obvious that south windows would catch the breezes from the southeast, south, and southwest; west windows would catch them from the southwest, west, and northwest. But west windows, it seems, are decidedly pre-

ferable from the standpoints of light and sanitation. Therefore, where the prevalence of south winds is very strong, as in the Southern States west of the Mississippi River, a choice of west or south windows may be difficult to make; but in the States east of the Mississippi River, generally speaking, it would seem that any sacrifice of other features to secure south breezes would be a mistake.

RADIO REPORTS GIVE TIMELY NOTICE OF RAINS IN CALIFORNIA.

By GEO. H. WILLSON, Meteorologist.

[Weather Bureau, San Francisco, Calif., April 26, 1923.]

From radio reports received twice daily at San Francisco from vessels in the North Pacific ocean the presence of storms and their approximate location is in nearly all instances known several days before their approach is indicated at coast stations, but the reports are generally so scattered that the direction in which the storm is moving and its rate of progression are too indefinite for use as a basis for a forecast. To make a definite forecast, that is, one that would be of any practical value, it is necessary to have sufficient data to know what the pressure distribution over the Canadian northwest, Rocky Mountain States and off the California coast will be about the time the storm is expected to reach the coast.

In general, a storm moving east or southeast from the North Pacific will not give rain in California unless its eastward movement is deflected southward by an area of high pressure over Alaska or British Columbia. When this is the case, the storm will, in nearly all cases, when about 500 or 1000 miles off the coast, develop a trough extending southward to about the latitude of San Francisco, and the center will enter the coast south of the Columbia river.

These conditions prevailed during the last week of March, 1923, and the writer was enabled to make a forecast of the approach of a storm several days in advance of its appearance on the coast. Subsequent comment by both the press and the public showed a deep appreciation of the work.

The storm which reached the Pacific coast on Friday night (March 30), and broke the long drought in California was first shown by a report from the S. S. *West Ivan* (en route from the Orient to San Francisco) on the morning of the 26th, when in latitude 37° N., longitude 151° W. On

the morning of the 27th, the *West Ivan* in latitude 37° N., longitude 148° W.; *Bearport* in latitude 39° N., longitude 154° W.; *Protesilaus* in latitude 52° N., 157° W., and the *Wairuna* in latitude 36° N., longitude 140° W., showed the cyclonic circulation around a large storm, but no high winds or low pressures were reported. On the morning of the 28th, the *West Ivan* reported a barometer of 29.44 inches, with fresh southeasterly winds and rain, and was nearing the center of the storm, while the *Bearport*, about 500 miles to the northwest, reported fresh northwesterly gales. Based upon these reports the following statement was made to the manager of the Associated Press: "A storm is central about 1300 miles off the California-Oregon coast moving eastward and will probably reach the coast about Friday evening (March 30) and extend later into California and break the drought." Advisory warnings were also sent to all ports from San Francisco north, advising shipping about to sail for the Orient of the location of the storm and the time it would reach the coast.

On the afternoon and evening of the 28th, the *West Ivan* sent the following reports:

1 p m, barometer 29.34, wind southwest, force 10; 3 p m, barometer 29.26, wind southwest, force 10; 9 p m, barometer 29.08, wind west, force 9, and at 11 p m, barometer 29.14, wind west, force 9—

Showing that she had passed through the center of the storm. At this time the weather was clear over the entire Pacific coast and a marked warm wave was in progress. Cloudiness began to increase along the coast Friday morning from San Luis Obispo northward; by Saturday morning rain had begun at all coast stations from San Francisco north, and by night the rain area had extended over western Washington, western Oregon, northern California, and the northern portion of southern California.

SOME TEMPERATURE AND HUMIDITY RELATIONS OF THE AIR.

By W. J. HUMPHREYS.

[Weather Bureau, Washington, D. C., May 2, 1923.]

The following is only a condensed, and slightly modified, derivation of some of the more interesting portions of an important paper by Dr. C. W. B. Normand, published in 1921 as Part 1, Vol. 33, of the *Memoirs of the Indian Meteorological Department*.

Let an aspiration psychrometer meet the following conditions, as it may to any required approximation:

1. That there be no net radiation gain or loss by the thermometer element.

2. That there be no addition of heat to, or subtraction from, the system, air, water vapor, and water, within and passing through the psychrometer.

3. That the exit air be saturated. This assumption is not necessary, but convenient.

4. That the pressure be constant.

Let T be the absolute temperature of perfectly dry intake air (if not fully dry, some of the following equations will need slight but obvious changes); T' the absolute temperature of the wet bulb; C_p and C'_p the specific heats of dry air and of water vapor, respectively, at constant pressure; and x the mass ratio of water vapor to dry air in saturated air at the temperature T' .

Then, counting from the freezing point, the heat in $1+x$ grams of saturated air at the temperature T' is

$(C_p + C'_p)(T' - 273)$, which, since the process is adiabatic, is equal to the heat in the initial stage,

$$C_p(T - 273) + x(T' - 273).$$

That is:

1. The heat content of any air equals the heat content of the same air saturated at its wet-bulb temperature minus the heat content of the liquid water required so as to saturate it.

2. The wet-bulb temperature of air adiabatically cooled, whether much or little, by evaporation into it from spray or other source, is constant.

3. If the wet-bulb temperatures of several portions of air are equal that of their mixture will be the same, however different their actual temperatures.

Furthermore, since the quantity of heat added to an object divided by the current absolute temperature of that object is the change in its entropy, the entropy per gram of dry air at the absolute temperature T , counting from 0° C. is

$$C_p \int_{273}^T \frac{dT}{T} = C_p \log \frac{T}{273}.$$

Similarly the entropy of $1 + x$ grams of saturated air at the absolute temperature T' , also from 0° C. is, since the specific heat of water is one,

$$C_p \log \frac{T'}{273} + x \log \frac{T'}{273} + \frac{Lx}{T'},$$

in which L is the heat of vaporization of a gram of water at the absolute temperature T' .

But

$$C_p \log \frac{T}{273} = C_p \log \frac{T'}{273} + \frac{Lx}{T'}, \text{ nearly,}$$

since, on putting $Lx = C_p(T - T')$, the expression reduces to

$$\log \frac{T}{T'} = \frac{T}{T'} - 1 - \frac{1}{2} \left(\frac{T}{T'} - 1 \right)^2 + \frac{1}{3} \left(\frac{T}{T'} - 1 \right)^3 - \dots = \frac{T}{T'} - 1,$$

nearly, which is true for all ordinary values of T/T' .

Hence, in Normand's words:

The entropy of any air approximately equals the entropy of the same air saturated at its wet-bulb temperature *minus* the entropy of the liquid water required so to saturate it.

ATMOSPHERIC TEMPERATURE AND THE CODLING MOTH.

By CHARLES C. GARRETT, Meteorologist.

[Weather Bureau, Walla Walla, Wash., Sept. 8, 1922.]

Among the numerous insect pests that infest the orchards of the United States and cause great losses to fruit growers, undoubtedly one of the most destructive of those that attack apples and pears is the codling moth. In a letter to the writer the District Horticulturist for the southeast Washington fruit district stated that in the season of 1918 the Yakima Valley apple growers suffered a loss of over \$2,000,000 due to the ravages of the codling moth alone. The Walla Walla district fared somewhat better, but the shipping data kept by the Horticultural Department showed that 28 per cent of all the apples were culls, and in accordance with the State horticultural laws were necessarily shipped to by-product plants, fed to hogs, or left to rot upon the ground. Conservatively speaking, at least 26 per cent of this total was accounted for by the codling moth.

The codling moth passes the winter in a cocoon, mostly under the loose bark of the trees. In early spring the larvae begin to transform into pupae, and soon after the apple blossoms have fallen the moths begin to emerge and continue to do so until the middle of summer. They lay their eggs chiefly on the leaves of the trees. On hatching, the young larvae seeks the easiest place to enter the apple, which is furnished by the calyx, or blossom end of the fruit, although a certain proportion enter through the stem end or through the skin. Between three and four weeks are spent by the larvae, or worms, in the fruit. Most of the wormy fruit falls before the larvae emerge.

In ordinary seasons, in northwestern apple districts, the codling moth has three generations and a partial fourth. Also, under ordinary weather conditions, the broods hatch at distinct periods. Dates of the main portion of each brood's hatching are determined, from which proper dates for spraying can be ascertained.

The means of control of the codling moth consist in covering the fruit and foliage with a poison mixture by spraying with a force pump. The first, or calyx spray,

is begun when most of the petals have dropped, with calyx cups still open to receive the poison, and finished before the calyxes are closed. Succeeding sprays, known as cover sprays, are applied at varying intervals during the late spring and summer seasons for combating the later brood larvae.

As the cost of spraying adds materially to the expenses of an orchard, it is very essential that the work be done when it is most effective, and that, in order to avoid waste, no more be done than necessary to combat the pests. Most progressive fruit growers have come to depend upon the advice of the State horticulturists for proper dates for spraying.

Codling moth cages, in which dormant larvae are placed early in the season, are distributed throughout a district, care being taken to have each cage correspond in every way to natural conditions. The length of time from the appearance of the moth, or adult butterfly, to the appearance of its offspring, the young larvae, is a known quantity, provided the atmospheric temperature is observed and recorded. While it has long been recognized that climatic factors influence the severity of the ravages of the codling moth, it was not until recent years that the close relationship that exists between the temperature of the air and the development and activity of the moths has been studied and charted. Here is where the services of the meteorologist are needed in cooperation with those of the entomologist and horticulturist.

In a letter to the writer, dated August 21, 1922, Mr. E. J. Newcomer, entomologist, United States Bureau of Entomology, who has been engaged for several seasons in deciduous-fruit insect investigations in the Yakima Valley, Washington, stated: "Codling moths do not deposit eggs when the temperature is below 60° F. Three fourths of the eggs are laid between 3 p. m. and 9 p. m." Mr. Newcomer kindly furnished a diagram which is repro-